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RECENT DEVELOPMENTS IN PRECORDIAL ELECTROCARDIOGRAPHY

This review is a supplement to one entitled "The Electrocardiographic Diagnosis of Cardiac Infarction," which we prepared three years ago for "Modern Concepts of Cardiovascular Disease." Its purpose is to bring the discussion of precordial electrocardiography up to date.

I. TECHNIQUE. Early in 1938, a joint committee of the American Heart Association and the Cardiac Society of Great Britain and Ireland recommended that electrode connections be changed so as to reverse the polarity of precordial leads, and established a standard nomenclature for them. A pamphlet containing this report may be obtained from the American Heart Association.

It would be premature, at this time, to attempt to decide on a standard technique for precordial electrocardiography. Investigators have experimented with a number of different leads in an attempt to arrive at the simplest adequate method; but, to date, there is no unanimity of opinion as to where the electrodes should be placed. At first, in the study of coronary thrombosis, attention was concentrated on leads with the precordial electrode at or near the apex impulse. However, as time went on, other leads were found to be helpful in certain cases, particularly when cardiac enlargement was present. In several patients with anterior infarction whose lesion was confined to an area in or near the interventricular septum, the most marked changes in chest leads were seen when the precordial electrode was placed halfway between the sternum and the left midclavicular line. Furthermore, in posterior and in the left lateral infarction, the most striking RS-T interval deviations in chest leads were seen as a rule when the precordial electrode was placed in the left anterior axillary line. Consequently, our present practice is to take three precordial leads, CF-3, CF-4 and CF-5. The right arm lead wire is attached to the electrode on the left leg; the left leg lead wire is attached to the precordial electrode, which is placed successively at the following three points, at the level of the apex impulse: (1) midway between the left sternal border and the left midclavicular line (Lead CF-3); (2) in the left midclavicular line (Lead CF-4); and (3) in the left anterior axillary line (Lead CF-5). The tracings are all taken with Lead II. We have used these three precordial leads in a series of normal individuals, and in quite a number of patients with heart disease, so that a background for their interpretation is developing. Our experience indicates that they give more adequate information than one lead alone, and are not much more trouble to take. We have not as yet found additional precordial leads which are necessary for routine work.

II. NORMAL CONTROLS. Because of the reversal of polarity, electrocardiograms taken with Leads CF-3, CF-4 and CF-5 are the inverted mirror images of those obtained by our old method. Normal tracings, instead of having a prominent initial downward deflection of QRS and an inverted T wave, have a prominent initial upward deflection of QRS and an upright T wave. If turned upside down and looked at in a mirror, they appear as if taken by the old method. This simple expedient is helpful to those who have difficulty in making an adjustment to the changed polarity.

The characteristics of Lead CF-4 will be described first because, when the heart is of normal size, this lead corresponds quite closely to one with which many are familiar, namely, Lead IV-F (in which an electrode at the apex impulse is paired with one on the left leg).

Lead CF-4. In 103 college students without evidence of cardiovascular disease, the following variations were noted: the total amplitude of QRS varied from 7 to 39 mm. Only two Q waves were seen, both less than 2 mm. deep. The R wave varied from 2 to 26 mm. The S wave varied from 1 to 33 mm. Marked notching of QRS, usually in the line connecting R and S, was seen in about one fifth of the cases. The RS-T interval was displaced upward about 2 mm. above the isoelectric line in one tenth of the cases, but never more than this. The T wave varied from 0 to 13 mm. in height; the two smallest, an isoelectric T wave and one measuring 1 mm., were seen in subjects in whom heart disease was not demonstrated. (Inverted T waves, and downwardly displaced RS-T intervals are seen in certain normal children, but have not as yet been encountered by us in normal adults.)

Lead CF-3. The R wave tended to be smaller in this lead than in CF-4, and the S wave tended to be larger. In one young girl without evidence of heart disease, and in several older people in whom heart disease was not suspected, Lead CF-3 showed no R wave at all, and an initial deflection of QRS which was downward. The T wave was much the same in CF-3 as in CF-4.

Lead CF-5. In this lead the R wave tended to be larger and the S wave smaller than in Lead CF-4. The S wave was often absent. Nearly a third of our normal cases showed a Q wave, but it never exceeded 2 mm. The T wave in this lead was much like the T wave in Lead CF-4.

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Many other chest leads were taken in our series of normal controls, but they need not be described here in detail. The CB leads (precordial electrode paired with one in the left interscapular region) usually showed larger waves than the CF leads (precordial electrode paired with one on the left leg). T waves which were less than 1 mm. high were seen in about 1% of cases in CB-4 (i.e., in about the same proportion as in CF-4). When the precordial electrode was placed to the right of the sternum (CF-1), the T wave was diphasic or inverted in one third of the cases and a Q wave was not uncommon. When the precordial electrode was placed above the third interspace, inverted T waves were not rare.

III. Patients with Heart Disease. With a few exceptions, the usefulness of precordial leads is confined to the diagnosis of the myocardial changes produced by coronary disease. The exceptions are: (1) the occasional case of auricular arrhythmia in which help can be obtained by a chest lead which will elicit a prominent P wave, i.e., a lead with the precordial electrode over the midsternum; (2) certain cases of pulmonary embolism; and (3) patients with localized myocardial lesions caused by conditions other than coronary disease, such as pericarditis, trauma, rheumatic fever, etc. This discussion will be confined primarily to coronary disease.

As in the case of normal controls, the precordial electrocardiographic patterns of the various types of cardiac infarction have been reversed by the recent change in polarity of chest leads. Thus the signs described in our discussion published three years ago in "Modern Concepts of Cardiovascular Disease" should be changed to the following:

Anterior Infarction. During the acute stage, the RS-T interval deviation in precordial leads is upward. After healing, the T wave becomes inverted. In the typical case, a deep Q wave appears shortly after the infarct occurs, and tends to persist. These signs are usually (but not always) more prominent in Leads CF-3 and CF-4 than in CF-5. When they occur in all three precordial leads, they probably indicate that the infarct is large.

Posterior Infarction. In Lead CF-5, during the acute stage, the RS-T segment is usually displaced downward. In Lead CF-4 this displacement may be less marked. In CF-3 it is often absent, and the contour of the tracing, normal. After healing, the downward displacement of the RS-T segment disappears, and the T wave tends to return to normal. There are no characteristic changes in the QRS complex of precordial leads in this type of infarction.

Infarction in the Postero-lateral Wall of the Left Ventricle. The characteristics of this lesion in precordial leads are the same as those of posterior infarction; the findings in limb leads distinguish it from posterior infarction. (Amercan Heart Journal, Volume 16, p. 387, October 1938).

The Huge T Wave Type. In precordial leads a very large inverted T wave probably signifies an anterior lesion; a very large upright T wave (over 15 mm.) may indicate the presence of a posterior lesion. These huge T waves are often picked up by one of the three precordial leads, and not by the others. The fact that the area on the precordium where these waves can be elicited is often very small, is one of the reasons for believing that the lesion in these cases is small. It is also an important reason for using more than one precordial lead.

Serial Tracings. Some patients with fresh coronary lesions fail to show definite indications of acute infarction in a single set of tracings, even when the three precordial leads are used with the limb leads. In such cases the acute nature of the lesion can sometimes be discovered if progressive change in the electrocardiogram can be demonstrated from day to day. If, however, variation in contour of the tracing is to be used to diagnose an acute lesion, other causes for it must be taken into consideration. (A) Changes in position of the heart and of the electrodes are very important in this respect: the patient should be in exactly the same position each time, and allowance must be made for hydrothorax, pneumothorax or change in abdominal distension. Moreover, the electrodes must be applied at exactly the same places when each set of precordial leads is taken; if this is not possible, the significance of alteration in the contour of the tracing may be uncertain. (B) Transient attacks of cardiac pain are often accompanied by temporary changes in the ventricular complex. Consequently it must be known whether the patient was having a brief anginal attack during the taking of one of the electrocardiograms; if so, a subsequent tracing after the cessation of pain might show a marked change, even though recent infarction were not present. (C) Some high-strung individuals without demonstrable heart disease have variations in T waves apparently as a result of physiologic phenomenal—exercise, tachycardia, etc. These must not be mistaken for evidences of recent infarction. (D) Changes produced by drugs (digitalis, quinidine, etc.) must be carefully evaluated. (E) Conditions other than coronary disease, which give rise to acute lesions in the myocardium may cause progressive electrocardiographic changes which are difficult to distinguish from those produced by coronary lesions.

IV. General Rules. In Leads CF-4 and CF-5 any Q wave more than 2 mm. deep, should be considered abnormal; if it is large it should suggest the possibility of former anterior infarction. In Lead CF-3, on the other hand, a prominent Q wave is to be interpreted conservatively, because this finding has been seen in persons who are apparently normal. Any inverted T wave in CF-3, CF-4 or CF-5 should be considered abnormal. An isoelectric or small diphasic T wave in any of these leads should be interpreted conservatively, because tracings of individuals without demonstrable heart disease may show such waves.

These general rules for precordial leads should be used, like all electrocardiographic rules, with a clear understanding of their limitations. Although we have never had cause to doubt the significance of the typical pattern of anterior or of posterior infarction, there are many other electrocardiographic deviations from normal whose meaning is less definite. Some may be caused by progressive, ultimately fatal lesions. Others may be due to minor congenital abnormalities, or to healed lesions which may not affect the functional capacity of the heart, now or in the future. When unexpected electrocardiographic abnormalities are found, the patient should be reexamined and questioned. Digitalis medication and a hitherto undiscovered coronary history are to be looked for with especial attention. If complete review of the situation fails to disclose any other sign of heart disease, the physician should keep an open mind as to the significance of the electrocardiographic abnormality. Advice to the patient should be designed so as to protect him from unnecessary apprehension as well as from danger.

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